Telescience Testbed Kickoff Meeting Minutes

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September 1987

Research Institute for Advanced Computer Science
NASA Ames Research Center

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The kickoff meeting for the Telescience Testbed Pilot Program was held on July 30-31, 1987 at NASA Ames Research Center. These are the minutes from that meeting.

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1. Overviews and Background

1.1. SAIS Testbed and Overview

Weiss (NASA HQ) gave an overview of the goals of the SAIS, which include:

(1) involvement of the user community in systems development for Space Station
(2) coordination of integrated systems for OSSA
(3) remote interactive access to system services and distributed resources
(4) design and development of a common user interface for all provided system services
(5) establishment of a long-term infrastructure

SAIS will provide the systems engineering and integration across all OSSA Disciplines and Missions for:

(1) access for scientific investigation
(2) facilitation of multi-disciplinary research
(3) creation of long-term infrastructure for OSSA information services

The SAIS Working Group is divided into four panels:

(1) Architecture and Networking
(2) Teleoperations
(3) Science Data Management
(4) Teledesign

Each panel is currently working on several white papers covering a variety of themes. Four main areas of technology, relating to Telescience, include interoperability (data handling, standards, access, interfaces, user support), distributed control, evolutionary system, and automation.

The SAIS Testbed Program Objectives are to:

(1) involve users in design and development of the overall system;
(2) test the applicability and feasibility of emerging technologies and methodologies toward implementation of the telescience concept;

(3) generate user interest and experience in dealing with the concepts for the space station era;
(4) validate system requirements and expand the requirements base; and
(5) refine science and system operations concepts.

Weiss concluded the overview of SAIS. the testbedding role and the University Consortium (TTPP), by summarizing the following NASA expectations:

(1) demonstration of University ability to address NASA problems
(2) demonstration of University ability to work with NASA designers
(3) ability of universities to perform liaisons with industry
(4) ability of universities to collaborate on issue resolution

1.2. Telescience Concept

The telescience concept was discussed, by Schmerling (NASA HQ), as an integral part of the needed science operations environment. He divided telescience into three sub-elements- teledesign, teleoperations, and teleanalysis. Teledesign is the ability to transmit data (written and visual), conduct tests, etcetera, remotely. Teleoperation is the ability to conduct remote operations. Teleanalysis is the ability to access and merge data from widely distributed sources, and to perform analyses and studies on computers at local and remote sites.

To make the TTPP work, strong investigator participation is necessary in the definition and design of needed capabilities for Space Station. Testbedding techniques will be used to prove the capability of the proposed designs. It will be necessary to do planning for science operations in all timeframes. Investigators will also participate.in payload crew member selection and activities scheduling.

A common operations interface is needed to support the overall project lifecycle. It should be unaffected by the use of different environments. Common protocols and standards should be implemented whenever possible, to ensure maximum distribution of and access to scientific results from the TTPP.

1.3. TFSUSS Recommendation

Wiskerchen (Stanford) explained the role of TFSUSS in advising NASA HQ how to build Space Station for effective and useful utilization. Prior to the creation of TFSUSS, NASA had been mission and engineering oriented. TFSUSS has succeeded in turning NASA's direction towards the user.

2. University Presentations - Earth Science

2.1. UC, Santa Barbara

Star explained UCSB's project to develop an on-line electronic catalog of an earth systems database. Their goal is to use researchers' existing data and equipment in a campaign-style experiment with Purdue. Participants' work will be coordinated by a working group.

Browse will be implemented as an interactive front-end. The Browse map windowing system will be used in connection with queries to the relational database. Data will include image and text.

2.2. University of Colorado, LASP

Cowley introduced the pilot study LASP will conduct on data acquisition and distribution. The purpose of this activity will be to provide a realistic testbed for evaluating key telescience concepts:

(1) coordinated scientific analyses
(2) campaign-style data acquisition
(3) teleoperations by distributed users

The Solar Mesosphere Explorer (SME) satellite and science data will be used to demonstrate distributed data acquisition, data access, data analysis and instrument command and control. The goals are to:

(1) provide remote access to SME database for coordinated teleanalysis
(2) evaluate data interchange formats and protocols
(3) provide coordinated SME measurements in support of proposed ground mapping campaign
(4) demonstrate teleoperations of SME from participating universities

The following issues will be addressed:

(1) coordination, communications and data management among distributed collaborators
(2) applicability of data interchange formats proposed for Space Station
(3) space instrument teleoperations by remote distributed users

2.3. Purdue

The elements of the Purdue experiment will include:

(1) testbed activities
(2) Purdue Field Spectral Database
(3) on-campus communications network
(4) off-campus communications network
(5) campaign-style experiment
(6) coordination with other testbed participants

Researchers plan to include experiment descriptions, spectral measurements and support measurements in their database:

(1) Spectral measurements would include band and numerical data.
(2) Support measurements would include pyronometer and meteorological data, as well as, science descriptions and geometric information.

The database will be stored on magnetic tape with mini-databases stored on disk. Access will be through software on the IBM 3083. Currently, no electronic catalog exists, so the user must have some knowledge of what tape the data is located on.

Database documentation includes:

(1) summaries of various experiments
(2) data library tape listings
(3) atlas of soil reflectance properties
(4) Larspec data formats
(5) Larspec User's Manual
(6) geometrical consideration and nomenclature for reflectance
(7) calibration procedures for measurement of reflectance factor
(8) reflectance calibration of panels
(9) papers describing vegetation and soils database

The database will be accessible by a variety of systems, including:

(1) Macintosh/III
(2) Sun Workstations
(3) Apollo Workstations
(4) Vax 11/780: Campus Engineering Network
(5) IBM 3083: Campus Computing Center

Current on-line database plans center on developing an on-line electronic catalog of the database; allowing access from on-campus networks and off-campus networks (Arpanet, Bitnet, Cypress, Telenet, NSFNet); placement of frequently accessed data on-line in a disk file; and investigation of possible uses of a Mac/III with optical disk for data machine and other computer systems to use for database.

2.4. University of Michigan

Conway discussed Michigan's experiments with a Fabry-Perot Spectrometer and their use of tele-autonomous control technology. Currently, Michigan researchers are studying the upper-atmospheric winds from the ground. In the testbed experiment, they hope to combine human and autonomous control (some manual and some automatic adjustments of the telescope), teleoperation in the presence of time delays and intelligent use of simulation, to carry out their tests. Eventually, they would like to move their base of operations further away, possibly to the South Pole.

Tele-autonomous technology involves remote manipulation. Researchers would like to study remote handling and time delay. Conway briefly described two time delay concepts: time clutch and position clutch.

In order to support the Telescience infrastructure, the Expres program is being utilized at Michigan. Expres offers multi-media communications and documentation, interoperability across different workstation types, and collaboration technology.

2.5. University of Wisconsin

Dedecker, of the University of Wisconsin, described the first phase Telescience objectives of their experiment as:

(1) build a bridge between McIDAS and USAN (TCP/SSEC PRONET)
(2) make McIDAS products available to network users
(3) get SME data from the University of Colorado and
(4) incorporate SME data into retrieval process and analyze its utility

McIDAS (Man-Computer Data Access System) will utilize an IBM 4381, running MVS. The McIDAS operating system runs:

(1) real-time ingestor software
(2) meteorological database management utilities
(3) video image display and enhancement utilities
(4) interactive analysis software
(5) terminal communications software

The McIDAS database is a large real-time database composed of:

(1) GOES VAS imagery and soundings
(2) NOAA TOVS imagery and soundings
(3) radar
(4) conventional surface and upper air observation
(5) lighting strike data
(6) meteostat and
(7) NMC products, including forecast model grid data

The database will soon include: NOAA AVHRR, DMSP (SSM/I, SSM/T), and GMS.

The planned bridge between McIDAS and USAN will allow a single session with a remote NSFNet station (University of Colorado) to ingest a data file into the McIDAS database. It will also allow a remote NSFNet user to acquire data products from McIDAS. Examples of current real-time McIDAS products include:

(1) PC EGA format GOES VISSR images

(2) PC EGA format RADAR images
(3) NMC grids
(4) PC EGA virtual graphics plots of surface and upper air observations
(5) raw GOES data
(6) raw sounding data
(7) PC EGA virtual graphics plots of surface and upper air observations
(8) SA text over the midwest

Access to McIDAS system software and utilities will not be permitted. Security for the McIDAS database and operations will be provided. McIDAS logon and data translation functions will also be provided.

Wisconsin researchers hope to use an IBM PC environment, since the nodes are accessible and it is relatively easy to change code and firmware. A truth table will be established and passwords will be unique but the logon will be standardized. The PCs will run MS DOS and use a PRONET token ring hardware adapter and an ETHERNET hardware adapter.

Software will be written to provide:

(1) SSEC PRONET protocol
(2) McIDAS logon and McIDAS session
(3) NSFNet logon and session to Colorado
(4) standard session interface to NSFNet users requesting McIDAS products
(5) TCP with FTP
(6) information transfers between McIDAS and TCP sessions
(7) translation functions
(8) security functions for McIDAS transactions

Possible follow-on activities for the TTPP could include: providing additional McIDAS products to the Telescience network; acquiring additional data, as identified by the TTPP, for augmenting the McIDAS database; and augmenting the bridge to include simultaneous sessions.

2.6. Stanford University

Bush discussed Stanford's use of the RSOC network, in conjunction with GSFC, JSC and MSFC. Stanford is establishing a data transfer network with Goddard (80 kb broadcast mode). They will then recreate Space Lab 2 experiments and do them remotely.

Stanford participants plan to compare operations at remote sites with operations at JSC. The goal is to determine where "bottlenecks" occur in the transmission and exchange of data between remote sites. Other objectives include determining communication, planning and scheduling requirements, and ascertaining the interoperability of different workstations.

3. University Presentations - Life Science

3.1. MIT

Lichtenberg outlined the MIT experiments in Life Science, which will be conducted in collaboration with the Simulated Space Experiment Facilities at KSC. PI surrogates will include, both individuals who have actual experience as PI's in Spacelab operations (e.g., Drs. Oman, Lichtenberg and Arrott) and, also, graduate students with ground experience in sled operations and science data interpretation. The surrogate crew members will come from the KSC Life Sciences Flight Experiment Division. There will be two simulated Space Lab experiments-- one previously performed on Space Lab 1 and one to be performed when shuttle missions resume.

The objective of the experiments will be to study the torsional eye movements of the subjects by recording them on video, using full bandwidth video. The cameras will be focused and positioned in real-time. Data refresh rates and transmission delays will be evaluated. The real-time data gathered will be analyzed for future modifications of experiment protocols.

Optokinetic Nystagmus (horizontal eye movements caused by moving the visual field and interaction with linear acceleration) will also be studied. Eye measurements, using both EOG (low data rate) and video (high data rate), and real-time data analysis will be used to enhance protocol modification.

MIT Life Science Testbed experiment objectives include:

(1) transmission of high-fidelity data to MIT
(2) data manipulation done on the MicroVax II workstation at MIT
(3) video manipulation done on a specially configured IBM/AT compatible computer
(4) investigation of the effects of the following:
   (a) data refresh rate
   (b) transmission delays
   (c) video data processing
      - scan rate (surveillance and data) and delays
      - resolution
      - enhancement
      - analysis rotation

(5) use measures of performance including:
   (a) time to complete experiment
   (b) number of errors
   (c) subjective ratings
   (d) amount of audio communications

4. University Presentations - Microgravity Science

4.1. RPI

Hahn of RPI will be working with co-investigators Glicksman, Doremus and Wiedemier. This experiment is designed to determine potential communications problems in remote experiment operations for microgravity materials processing. Researchers will visit Lewis Research Center and learn how to operate the equipment there. They will return to RPI to operate Lewis' equipment remotely via voice communication (telephone lines). Video will be utilized for control purposes only, not data.

Experimentation will be conducted with:

(1) real-time video, full data capability, voice communication to operate remote instruments
(2) slow scan video, limited data, voice
(3) slow scan video, data degradation

5. University Presentations - Astronomy

5.1. SIRTF

5.1.1. Ames Research Center

Stauffer of ARC gave an overview of the SIRTF (Space Infra-Red Telescope Facility):

(1) a 0.9r cryogenically cooled infra-red telescope
(2) one of the "Great Observatories"
(3) the infra-red equivalent of the Hubble Space Telescope
(4) will provide infra-red maps of the sky, approximately ten times faster than previously available
(5) free-flyer but will be serviced from Space Station

The instruments and the science working group for SIRTF were selected in 1984. Currently, it is in the extended definition and technology development phase. The present schedule calls for a hardstart in 1992 and launch in 1996.

The SIRTF instrumentation will include:

(1) an infra-red array camera (IRAC) operated at Smithsonian Astrophysical Observatory by Fazio (GSFC)
(2) an infra-red spectrometer (IRS) operated at Cornell by Houck and
(3) a multiband imaging photometer (MIP) operated at the University of Arizona (BASD) by Rieke.

SIRTF is interested in participating in the TTPP because the SIRTF Science Operations Center (to be located at ARC) will be designed from the start to use Telescience. SIRTF may produce approximately the same data flow as HST but it will require a much smaller staff and budget for the same results. SIRTF will rely on the efficient use of Telescience methods to provide a similar level of service as STCCI.

Plans for SIRTF SOC call for:

(1) SIRTF-specific software to be written by the various PI teams and transferred to SOC via networks
(2) observing proposal submission and review via networks
(3) astronomer absent from SOC during observations; notified of successful observations via networks; quick-look examination of observations possible via networks
(4) routine data reduction by SOC
(5) data routinely processed and either transferred via networks to PI or PI can login to SOC system for remote data (should support varying operating systems and terminal types; CAI available
(6) remote archive access

The telescience testbed will need to establish the SOC in approximately years. Much of the SOC design will be developed by members of the SIRTF Working Group, who are not currently familiar with Telescience. Current SIRTF activities are aimed at gaining telescience experience.

The conclusion is that Telescience will be an integral part of SOC. Astronomers will need to learn enough to design SOC to provide complete services to users with a minimal on-site staff.

5.1.2. University of Arizona

Erick Young gave the Arizona presentation for SIRTF. The Arizona SIRTF instrument is MIPS (Multiband Imaging Photometer for SIRTF). The goals of the instrument are to provide a photometric capability for SIRTF, at wavelengths between 3 and 700 um, that is limited only by celestial backgrounds or source confusion.

The telescience effort at U. of A. consists of three main parts:

(1) access and remote processing of a large astronomical database. In particular, the plan includes a link between Arizona and the Infrared Analysis and Processing Center (IPAC) at Caltech that will allow the remote processing of both catalog and image data. Technical issues include: the needed data rates, image formats, need for data compression, and user interfaces.
(2) remote observing with a 2.5 um HgCdTe array camera. The computer at the observatory will be linked to the downtown facilities, using 9600 bps modems. Format images (64 x 64) will be transferred from the mountain to the workstation linked to the workstation downtown.

This will allow processing, such as, flat fielding, source extraction, image enhancement, and catalog comparison.
(3) interchange of SIRTF related data between the investigative teams at Arizona, SAO, Cornell and ARC to demonstrate a teledesign environment.

Arizona's SIRTF experiments will include:

(1) teleplanning- observation requests, satellite scheduling
(2) teleoperations- observation monitoring, adjustments to observations
(3) teleanalysis- calibration and pointing of telescope
(4) telearchives- remote screen as data archive
(5) teledocumentation

Arizona will simulate a telescope on a MicroVax workstation and remotely operate the simulation, using OASIS software on a second workstation. In phase two, they will design, construct and install interfaces between a remote workstation and a telescope, and conduct an actual observation at Allegheny from Arizona. In the final phase, instruments will be replaced with the actual system planned for Space Station. The ground based system will be used to accurately test and verify a complete Space Station observing program.

The ATF program will address the following questions:

(1) standards
  (a) interfaces
  (b) protocols

(2) telescope controls
  (a) formats
  (b) data rates
  (c) error control
  (d) safeguards
  (e) time delay effects

(3) data and telemetry
  (a) source coding for data compression
  (b) data rates
  (c) error control
  (d) backup storage requirements

(4) maintenance, calibration and testing
  (a) extent of on-board assistance
  (b) requirements for data, voice and video
  (c) time delay effects

5.1.3. Cornell

Koch (SAO) spoke on behalf of Herter (Cornell) and described Cornell's plans for the TTPP. Cornell will work in collaboration with the University of Rochester, IPAC (Infrared Processing and Analysis Facility) and SAO.

The objectives of the experiment are to provide for remote access, transfer and analysis of IR CCD image data, and to remotely access database information, perform on-line analysis and, as necessary, transfer image data for further analysis. Cornell researchers will evaluate various networks to determine which is the most effective and reliable for each application. Once the "best" choice of networks has been made, they will perform detailed testing (through the teleanalysis of data) to address the following telescience issues:

(1) need for access to data and performance of analyses without sacrificing current technologies
(2) comparison of direct hardware compatibility versus an "equivalent system" approach
(3) appropriate mix of on-line processing versus remote transfer and analysis
(4) requirements for the establishment of techniques and standards for telescience applications for astronomy
(5) identification of these standards and their levels

5.1.4. SAO

Koch offered an overview of SIRTF's role in the TTPP and SAO's part in the program. SIRTF's goal has been to operate in a remote observing mode, conducting most functions from home institutions. This has been achieved through:

(1) teleplanning: expert systems
(2) teleoperations
(3) teleanalysis: standard software; APIS, IRAF
(4) telearchives: DBM for archiving, sear and retrieval
(5) on-line documentation and CAI

General SIRTF objectives are to:

(1) survey what networks, hardware and software users have (will be typical of that generally available to users)
(2) identify networks, hardware and software for carrying out telescience and SIRTF operations
(3) test network performance required for interactive telescience to be viable
(4) transfer data and perform remote processing of images
(5) port software to other sites to demonstrate sharing of resources
(6) establish structure for computer assisted instruction (CAI) and on-line documentation so users can learn how telescience works

The specific tasks to be undertaken in the TTPP are:

(1) installation of T1 links between telescopes and Tucson, using the existing ARPA/NSF Internet between SAO and Tucson to complete the link
(2) using network from SAO to Mt. Hopkins:

- (a) port software to support InSb array development
- (b) perform remote software development and debugging
- (c) evaluate usefulness for s/w porting and debugging
- (d) transfer images from InSb array to SAO for processing
- (e) evaluate usefulness for operations and analysis
- (f) evaluate network performance and experiences
- (g) report on recommendations for improvements of n/w

(3) evaluate the usefulness of networks, in conjunction with SIRTF Co-Investigators, for porting, debugging and data exchange:

- (a) specifically support installation at University of Rochester
- (b) port software of common interest for array development
- (c) transfer images from testing for processing and evaluation

(4) evaluate, in conjunction with SIRTF Co-Investigators, the level of commonality and standardization necessary to make telescience practical and efficient
(5) evaluate, in conjunction with SIRTF Co-Investigators, network performance and experiences while carrying out above tasks
(6) evaluate techniques used with existing large astronomical databases

The testbed at SAO:

(1) SAO had previously obtained consultant services for links
(2) recommendations for hardware procurement were obtained and orders placed for long lead items
(3) filing made with the FCC for frequency allocations
(4) InSb array was arranged for:

- (a) delivery in August
- (b) first cool down in October
- (c) data acquisition interface to MicroVax

(5) InSb data acquisition software for MicroVax
(6) anticipating SAO institutional funds for buying new GPX for Tucson

In the future, SAO hopes to begin telearchiving from SAO, Cambridge to Mt. Hopkins, Tucson, to provide on-line image and spectral data taken at Mt. Hopkins. This way, the observer can compare new measurements in real-time with previous data, to identify changes in same source, similarities in others, etcetera.

Upgrades to the BIB array will be made and a data acquisition system will be added. These projects are necessary due to development evolution:

(1) data acquired with LSI-11
(2) data written to floppies
(3) floppies mailed to GSFC
(4) converted to 9-track tape
(5) mailed to SAO
(6) image processed at SAO
(7) feedback to observing program in days and weeks

They will also be necessary due to the improved telescience approach:

(1) data acquired with MicroVax-GPX
(2) MicroVax to provide data quality checking
(3) image transferred from UKIRT at Mauna Kea via Starlink to Edinburgh
(4) data transferred via SPAN to SAO
(5) image processed at SAO
(6) feedback to observer within hours

5.2. University of Colorado

Cowley introduced the LASP astronomy testbed which will demonstrate Space Station telescience concepts and identify any problems in a realistic, scientific environment. Specifically, remote operations of one or more ground astronomical and solar observatories will be established to:

(1) investigate impacts of remote control and monitoring of sophisticated scientific instruments
(2) enable a large number of scientists to experience remote operations
(3) determine how experiment strategies could be enhanced for remote operations and investigate new experiments enabled by these technologies
(4) learn how to coordinate observations among distributed users

Implementation will be undertaken in the following stages:

(1) interface OASIS to telescope at Sommers-Bausch Observatory (U of C)
(2) incorporate data/video links and demonstrate across-campus remote operations
(3) demonstrate full-up teleoperations of a telescope at a major observatory, such as:

  (a) Space Environmental Laboratory's Solar Observatory, Boulder
  (b) Smithsonian's Observatory, Mt. Hopkins, Arizona
  (c) University of Arizona's Steward Observatory, Tucson
  (d) Kitt Peak Observatory, Arizona

(4) follow-on tasks will be conducted at the Allegheny Atmospheric Telescope Simulator (in support of a proposed University of Arizona testbed)

Implementation at Sommers-Bausch Observatory has begun with an Apple II controller and the definition of interfaces has gotten underway.

The following issues will be addressed via the teleoperations of the ground observatory:

(1) methods for insuring safety of on-site crew and instrument
(2) burdens of light-time delays and limited sensory information
(3) desired enhancements in control feedback
(4) effectiveness of user interface designs
(5) coordination of control among distributed users
(6) ability to respond to targets of opportunity
(7) division of control between remote user and local automation
(8) modification of instrument and experiment designs to enhance teleoperations

5.3. MIT

Baron discussed the way TTPP integrates teaching and technology. MIT will utilize an "generic computer", which runs Unix, which, in turn, activates COSMAC. COSMAC is a small computer which will carry out the actual work on the experiments at Wallace Observatory.

Bradt explained the Xray Timing Explorer (XTE) and how it would be used in their telescience experiment. The goal is to allow instantaneous data retrieval with transparent access to instruments for the observer.

GSFC will collaborate with MIT to provide data on-line to MIT as it arrives at Goddard. The time delay should be less than one second for plotted data.

5.4. UC, Berkeley

Chakrabarti outlined UCB's telescience collaboration with MIT, Stanford and possibly, GSFC. Berkeley's two main areas of areas of activity will be telescience and teleoperation. In the teledesign area, there will be hardware simulation and software development over Arpanet. Teleoperations will concentrate on transaction management methodology (remotely sending instructions).

Remote software development will be initiated in order to share the expense, manpower and expertise of the institutions involved. It will be accomplished using a WAN between MIT and UCB systems, and an "extended software control system."

The software control system:

(1) insulates users from developers
(2) controls propagation of changes

(3) makes executable and source code available across the network
(4) allows software to exist in one of the following three states:
  (a) New: active development
  (b) Test: being evaluated
  (c) Operational: very stable and accessible to users

(5) makes the user transparent
(6) shows code usage by the entire project
(7) is currently used separately at UCB and MIT

UCB plans the simulation of the digital portion of the EUVE and several electronic modules. They will utilize "real" instrument software. UCB's goals with teleoperation include:

(1) methodology of remotely running the EUVE payload; and
(2) transparent payload command handling facilities

5.5. Sun Workstation Futures

Gage, a representative of Sun Microsystems, gave a brief overview of future Sun workstations in development.

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6. Related Activities

6.1. Intelligent System Architecture

Grant (ARC) discussed the Architecture Program being undertaken by his group and their goals:

(1) to develop architecture requirements for intelligent systems applications across all future NASA missions
(2) to identify and develop state-of-the-art architecture design methodologies:
  (a) knowledge base design capture
  (b) simulation/emulation
  (c) verification and validation

(3) to establish an experimental architecture program with initial focus on an Intelligent Systems Manager

The program will attempt to understand the SSIS operations management at the system level and to develop systems level design rules for reliability, efficiency and performance. Centralized versus distributed techniques will be studied.

The approach will include:

(1) analytic and experimental techniques applied to distributed real-time system management issues
(2) focus on fault handling and quantified analysis of impacts on SSIS performance
(3) coordination with JSC engineering and operations groups and for testbed evaluations of unique requirements
(4) trade studies of centralized versus distributed techniques
(5) development of design requirements and performance knowledge-base for system knowledge capture and communication

6.2. Planetary Data Systems

Blake, of the University of Hawaii, discussed the PGD's attempt to put planetary data sets into common format and to provide researchers teleaccess to that information.

PGD is currently involved in studies of planetary and terrestrial geology, using primarily remote sensing methods; instrument development (spectroscopy); and software development (spectroscopy, image processing, and image cube processing). They are also working on several cooperative projects, including:

(1) PDS (Planetary Data System)
(2) NIMS instrument development (Galileo)
(3) VIMS instrument development (Facility Institute????)

PDS started with Code E and was funded by them. It was the result of a merger between two previous projects-- the PPDS (Pilot Planetary Data System), which was to assess technology relevant to making planetary science data easily available, and PDSP (Planetary Data System Project), which was to develop an operational planetary data system.

PDS is composed of three parts:

(1) technology evaluation - teleaccess
(2) integrated science testbed evaluation - teleanalysis
(3) development of an operational system

The PDS approach involves:

(1) a unified approach (common set of rules and standards)
(2) use of distributed nodes (support natural evolution)
    (a) distributed database
    (b) distributed project control
    (c) distributed data handling and management
    (d) central node at JPL coordinates the effort

(3) participants directly linked across telecommunications lines (SPAN, telemail, modem), in order to facilitate access to and analysis of data

Participants in the project are:

(1) Washington University (RPIF) - mission interface, image processing
(2) University of Hawaii (PGD-RPIF) - spectroscopy, earthbound instruments
(3) JPL - planetary rings
(4) JPL - navigation ancillary information
(5) JPL (RPIF) - database development, catalog standards, image data curation
(6) USGS, Flagstaff - radiometry
(7) LASP - atmospheres
(8) UCLA - fields and particles

Two related activities are:

(1) Pilot Land - JPL and GSFC
(2) Pilot Ocean - JPL

At the University of Hawaii, Blake is trying to catalog and define data to be included in the database. She is using an IBM PC environment and will develop a prototype spectral DBMS, integrating attributes, data and search procedures (INGRES). Telecommunication links will be set up to make data and proto-DBMS available to the general community. Follow up activities will include evaluations of the results of the INGRES-based proto-DBMS and search relations.

Spectral data sets to be made available, which will represent all planetary bodies, include:

(1) laboratory data
(2) telescopic data
(3) spacecraft data
(4) spectra extracted from and linked to hyperspectral data sets (e.g., AIS, AVIRIS, NIMS, VIMS)

Blake summarized the telescience objectives of the PDS project at UH as:

(1) to assist in the development of cataloging and data management standards/ protocols for planetary data sets
(2) to develop a prototype/testbed spectral DBMS with teleaccess capability to:

(a) evaluate the adequacy of PC architecture
(b) explore SUN architecture

(3) to evaluate search relations embedded in this DBMS (based on user reactions) and to evaluate teleanalysis capability

7. Technology

7.1. Stanford University

Wiskerchen reviewed the following:

(1) SUNSTAR - Stanford University Network for Space Telescience Applications Research Program
(2) CASIS - Center for Aeronautics and Space Information Sciences and OAST Information Sciences Technology Research
(3) Remote Space Science Operations Center - which is involved in Telescience research for Shuttle payloads Testbed for Space Station Telescience R & D
(4) joint efforts in research for payload design, integration and operations, with MSFC, GSFC, JSC, KSC, ARC, LeRC
(5) a new national program in AI, expert systems and robotics, with Space Station as the focal point

The CASIS Research Areas include:

(1) concurrency studies
(2) high speed local area networks
(3) high performance VLSI Signal Processors
(4) parallel computing arrays for signal processing
(5) advanced concepts for remote Space Science Operations
(6) telecommunications research
(7) network graphics and user interface architecture
(8) large volume database management
(9) digital speech research
(10) AI and Expert Systems
(11) robotic sensing and perception
(12) ADA language development
(13) advanced video architectures

Wiskerchen discussed Stanford's plan to cooperate with industry and government, in attempt to evaluate and meet the new technology needs for Space Station - the concept of "industry affiliates."

7.2. University of Arizona

Schooley (Astronomy-U of A) briefly discussed the work they plan to do in remote fluid handling. Arizona had planned to build a robot which was capable of handling micro-measurements but will, instead, collaborate with the University of Michigan and utilize the "time clutch" and other automated equipment in their experiments. They will make use of OASIS at the University of Colorado and control their robot from Arizona. Arizona will study the suitability of packet-switching for real-time control.

Questions to be addressed include:

(1) How often should remote data be updated?
(2) What are the effects of time delays?
(3) How much computing needs to be local versus remote?

He also detailed the Arizona efforts in Astronomy for the TTPP. The initial activity will be the remote teleoperation of an Astrometric Telescope Facility (ATF). The primary goal of the demonstration is the detection of other planetary systems and calculation of masses and orbits. This will be done by repeated observations of small motions of target stars relative to a fixed distant stellar background.

Ultimately, they hope to remotely operate a reflecting astrometric telescope aboard Space Station, which will allow:

(1) detailed and repeated studies of preset population of many star fields
(2) a main observing program fixed weekly and uploaded (requires telescope pointing and instrument reconfiguration)
(3) data from multichannel astrometric photometer transferred in near real-time
(4) more flexible guest-investigator program

(Refer to the SIRTF section on Day One for further details.)

7.3. University of Colorado

Davis gave an overview of the OASIS project at LASP. OASIS operates a scientific instrument teleoperations package. It is sponsored by OSSA. OASIS utilizes a command language called FORTH. The goals in OASIS development are:

(1) to prototype Space Station concepts
(2) port software to other computers and operating systems
(3) add new function to the package
(4) develop and maintain open architecture (written in ADA)
(5) enhance performance

The restrictions to OASIS are:

(1) closed architecture
(2) it currently operates on Vax/VMS only
(3) performs with high data rates or heavy processing loads

LASP is currently developing new versions of OASIS to overcome these limitations. Version 2.5 will be faster, able to add new functions with no recoding and portable to Sun/Unix environment. It will be available in nine months. Version

3.0 will take an object-oriented approach to promote open architecture, improved user interface and extended capabilities. It will be completed in 15 months.

For the TTPP, LASP plans to:

(1) make the current version of OASIS available to all Consortium participants
(2) develop version 2.5 with Consortium applications in mind, to include reactive control and interlock capabilities. and real-time display and manipulation of science data objects like spectra and images
(3) develop version 3.0 as a cooperative effort of the Consortium with members participating in the design of the overall architecture, user interface development, development of communications protocols and display modules, and development of general-purpose data processing and display modules.

LASP will develop a prototype operations management module that will provide reactive control and interlocking for scientific operations. This operations management capability will be incorporated into two Consortium testbeds: the SME satellite for remote control of science instruments aboard the SME and ground-based observatories, enabling the remote control of telescopes.

Within the TTPP, participants can be a major force for development and validation of teleoperations concepts. The TTPP members can become more involved in teleoperations development through:

(1) participation in the development and testing of concepts for the Space Station User Support Environment (USE), including object-oriented user interfaces
(2) use of proposed standards - like CCSDS recommendations
(3) development of specification and guidelines for teleoperations interfaces between instruments, users, ground support equipment and spacecraft
(4) development of software in ADA

7.4. University of Maryland

A'Hearn explained Maryland's role as a ground-based astronomical institution involved in teleoperations and telemaintenance. Their testbed goals are:

(1) real-time target acquisition with reduced bandwidth
(2) remote alignment of optics
(3) test of standardized versus optimized controls and programs
(4) test of distributed control

Various facilities cooperating with the testbed activities include:

(1) Berkeley, Illinois, and Maryland - mm interferom
(2) itinerant CCD - spectrometer/coronagraphic camera

(3) heterodyne system

Maryland will attempt real-time acquisition with reduced bandwidth by:

(1) IVE. Astro. experience
(2) Approaches:
  (a) "IPCS"
  (b) "IPCS" and subframe
  (c) pattern match
  (d) forward simulation
  (e) log

(3) test with variety of users:
  (a) optical/uv/radio
  (b) instrument PI/GO
  (c) remote/on-site

8. Connection to Related Activities

8.1. End-to-End Testbed Overview (ETC)/Goddard Space Flight Center Efforts

Moe gave an overview of how the End-to-End Testbed works. Users are asked initial questions as to their needs. From these discussions, paper prototypes are developed. The next step is to develop a rapid prototype on-screen. The on-screen version has no software behind it. It is just a visual representation of the types of format, data, etcetera, that the users would like available on-line. Since there is no software development involved, it takes little time to set up a demonstration model for further refinement, before the actual s/w development is begun. Next, an operation interface is established for further testing. Finally, baseline recommendations for an "operational application systems" are made.

The purpose of the End-to-End Testbed is to utilize user involvement to establish needs and uses.

8.2. Johnson Space Center DMS and C&T Testbeds

Markham discussed the Data Management System (DMS) at JSC. The DMS will make use of a twin fiber optics, token ring network with a C & T interface. JSC also wants to have an ISO prototype.

Currently:

(1) the video format for Space Station has not been chosen
(2) the scientific user will have access to the video system

(3) the user can either:

(a) use Space Station video equipment (camers, monitors, vcr, etc.); or
(b) provide their own video equipment

(4) if they provide their own, they must convert to Space Station format in order to display onboard
(5) low rate, compressed digital video (<10Mbps) can be placed on the DMS network for transmission to ground

Questions to be answered concerning the use of video on Space Station:

(1) Are scientific users interested in interacting with the video testbeds?
(2) What is the time frame?
(3) What is the purpose?

The audio format for Space Station is also TBD but ISDN seems to be favored at the present time. The plan is to provide standard PBX audio features. But the questions remains: Do scientists expect to interact with the audio system on Space Station?

Individual optical fibers are planned from high rate payloads to the C & T signal processor. There are no value-added services planned for the signal processor. The question for the high rate links is: Would anyone like to interact with the high rate payload links?

Whitelaw (JSC)

9. Networking and Workstations

9.1. NSI/Infrastructure

Van Kamp and Jones of ARC explained the goals of establishing a NSI connection at each university participant site. These include:

(1) promotion of communications between NASA and science researchers
(2) cost-cutting through shared and efficient resources

The plan is to use only one connection at each campus. The approach is to use:

(1) multiples of 56Kbps
(2) TCP/IP - can use DECNET with limitations, vendor independent
(3) PLDS - Pilot Land Data Systems as pilot system

The strategy will be to use a national backbone (NSFNet), regional networks and campus networks (MOAs).

Jones gave some background on NSN at Ames, which started in 1987 for OSSA and Villasenor. The Internet is a network of networks - packet networks with gateways not bridges.

9.2. Sun Workstation Environment

Slocum presented the Sun workstation infrastructure. RIACS will be providing recommendations for hardware and software environments, and will support a loose collection of software for the Sun workstation which will be cheap or free for telescience users. This target infrastructure includes, in part, Sun Unix, Sun Windows, Suntools/Sunview, the C shell, support shell scripts, Gnu Emacs, C, Fortran, possibly Ada, the Rand MH mail handler, Diamond, Latex and Tex, as well as the standard Unix utilities. The infrastructure is migrating towards future components, including Mach, NeWS/X.11, Distributed Object Oriented Programming Environments, Ada, and distributed, transparent resource sharing.

9.3. MicroVax Workstation Environment

Bush briefly explained that Stanford will be filling a role similar to RIACS', by developing a MicroVax/VMS environment for use by participants working with Vax workstations, rather than Sun equipment.

9.4. Diamond/Expres

Conway (U of Michigan) explained some of the uses of Expres in the TTPP, to aid in widespread distribution of research via multimedia means. There was not enough time to cover Diamond

10. Discussion and Action Plan

An action plan was suggested, as follows:

(1) develop coordinated plan with other communities, such as, SAIS Working Group, etcetera:

- (a) ESADS
- (b) PDS
- (c) CODES (ETC, TMIS, SSE)
- (d) CDOS
- (e) OTF
- (f) OMS Working Group

(2) surface useful common software (RIACS, Stanford)
(3) interconnect to ETC (Code E/S)
(4) arrange for information distribution to the TTPP Community (RIACS)
(5) NSI Primer (RIACS)
(6) Mailing Lists:

(a) TTPPMGT
(b) UTEE
(c) address: name@riacs.edu: name@icarus.riacs.edu; name@hydra.riacs.edu
(d) telemail: to: postman/arc (first line); to: name@riacs.edu <blank line>

(7) monthly status reports. working groups, quarterly headquarters reviews by PIs
(8) identify campus NSI site manager (all)

11. Agenda

Telescience Testbed Pilot Program Meeting
July 30-31, 1987
FINAL AGENDA
July 30

0800-0830	Coffee and Doughnuts		
0830-0850	Welcome and Introductions		B. Leiner
0850-0910	SAIS and Testbed Overview		J. Weiss
0910-0930	Program Overview		E. Schmerling
0930-0945	TFSUSS Recommendation		M. Wiskerchen
0945-1000	BREAK		
1000-1145	EARTH SCIENCE:		J. Star
	UC Santa Barbara	J. Star	
	U of Colorado	J. Cowley (5 mins.)	
	Purdue	R. Collier	
	U of Michigan	L. Conway	
	U of Wisconsin	R. Dedecker	
	Stanford	R. Bush	
1145-1205	LIFE SCIENCE:		B. Licthenberg
	MIT	B. Lichtenberg	
1205-1330	LUNCH		
1330-1350	MICROGRAVITY SCIENCE:		R. Hahn
	RPI	R. Hahn	
1350-1555	ASTRONOMY:		D. Koch
	SIRTF		
	Ames	J. Stauffer	
	U of Arizona	E. Young	
	Cornell	D. Koch	
	SAO	D. Koch	
	U of Colorado	J. Cowley (5 mins.)	
	MIT	R. Baron	
	UC Berkeley	S. Chakrabarti	
1555-1610	BREAK		
1610-1655	Presentations on related activities		
	Sun Workstation Futures	J. Gage	

Telescience Testbed Pilot Program Meeting
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FINAL AGENDA
July 31

0800-0830	Coffee and Doughnuts		
0830-0850	Related Activities (continued)		
	Intelligent System Architecture	T. Grant	
	Planetary Data Systems (U of Hawaii)	P. Blake	
0850-1010	TECHNOLOGY:		B. Leiner
	Stanford	M. Wiskerchen	
	U of Arizona	L. Schooley	
	U of Colorado	R. Davis	
	U of Maryland	M. A'Hearn	
1010-1210	Session on connection to related activities This will focus mainly on the relationship of our rapid-prototyping user-oriented testbed to the ETE Testbed being put in place as part of the SS Program.		
	End-to-End Testbed Overview (ETC)	K. Moe	
	Goddard Space Flight Center Efforts	K. Moe	
	Johnson Space Center DMS & C&T Testbeds	W. Marker/ V. Whitelaw	
	Discussion (1 hour)		
1210-1340	LUNCH		
1340-1520	Session on networking and workstations This will focus on progress in putting in place the NASA Science Internet and how it can be used to support our program, and also on the role that a "standardized" telescience workstation software environment can play in helping us be more effective.		
	NSI/Infrastructure	W. Van Camp	
	Sun Workstation Environment	M. Slocum	
	Microvax Workstation Environment	R. Bush	
	Diamond/Expres	L. Conway	
1520-1535	BREAK		
1535-1700	Discussion, actions, and plans.		